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THE EFFECTS OF HERBICIDES IN SOUTH VIETNAM
PART B. WORKING PAPERS: THE ECOLOGICAL ROLE OF
BAMBOOS IN RELATION TO THE MILITARY USE OF HERBICIDES
ON FORESTS OF SOUTH VIETNAM

NATIONAL ACADEMY OF SCIENCES-NATIONAL RESEARCH COUNCIL

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The Ecological Role of Bamboos in Relation to the Military Use of
Herbicides on Forests of South Vietnam

WILLIAM B. DREW^a

The principal objective of this study was to find out whether bamboos had replaced broad-leaved trees in the forests of South Vietnam (SVN) as a result of military defoliation, and, if so, on how large a scale. The work was primarily concerned with the Closed forest (Foret dense) because of the much greater amount of commercially valuable timber it contains compared to forests of other types. Secondary objectives were to investigate (1) the soil and other habitat preferences of the various species of bamboo; (2) the effect of herbicides, swidden ("slash-and-burn") agriculture and fires on the spread of bamboo within the forest; (3) the success of different means of reproduction by bamboos; and finally, (4) to assess briefly the possible economic value of bamboo colonizing former forest.

For reasons of security, very little field work was possible in the Closed forest, but limited observations were made along the highways to the Col-de-Blao (Route #20, Lam-Dong Province), An-Loc (Route #13, Binh-Long Province), Tay-Ninh City (Tay-Ninh Province), and Trang-Bom to Xuan-Loc (Route #1, Long-Khanh Province). Three helicopter trips in War Zones C and D provided some additional observations from the air, plus one brief ground visit to a defoliated forest site with bamboos at a fort near

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Cau-Muoi-Mot (Route #14, Phuoc-Long Province), and one brief visit to an unsprayed forest near Dong-Xoai (Phuoc-Long Province). Both latter sites could only be visited for one to two hours under maximum security provided by Vietnamese and American armed forces. Under these circumstances, an assessment of the role played by bamboos in the ecology of Closed forests sprayed with herbicides can only be regarded as tentative.

AREA WITH DOMINANT BAMBOO COVERAGE

Bamboos were already present prior to the military use of herbicides in many types of forest in SVN, especially in secondary and much disturbed areas. In secondary forests they became dominant over considerable areas where they are said to persist for many years. These "bambusaies" are mapped as a distinct vegetation type in the map prepared by Rollet (1956).

In the lowland secondary Closed forest without dominance of bamboos, there were nevertheless bamboos scattered about in the understory, especially on schistose slopes and red soils (Rollet 1962?). Rollet points out that these stands of bamboos on such soils can frequently colonize an area relatively rapidly. It was also noted by Rollet (1962?) that in the open forests (with Lagerstroemia and leguminous trees) there is generally also an understory of bamboos (Oxytenanthera sp.) that are either evergreen or deciduous in the dry season.

In the highlands, at a medium elevation of 1800-3800 ft, there may be extensive stands of bamboos in the secondary Closed forest. These areas are noted by Rollet on his Vegetation Map, and in his Notes (Rollet 1962?). All told, prior to the application of herbicides for military

purposes in SVN there were an estimated 1.4 million acres in which bamboo were already well established as dominant species in the "bambusaies."

SPECIFIC BAMBOOS IN CLOSED FOREST ECOSYSTEMS

There are a number of species of bamboos normally associated with the primary and secondary aspects of the Closed forest. In the primary forest, Bambusa sp.^a (Kring of the Montagnards) may form rather large, pure populations on specific sites, e.g., on alluvial borders of streams, and especially on the slopes adjacent to them (Barry et al. 1960). However, these authors note that in secondary forest arising from the ray (slash-and-burn areas) the bamboo Kring generally appears in 10-15 years, and in 20 years has developed into a "sea of bamboo" which is said to persist for a century or more.

Further observations on the species of bamboos found in SVN were made by Schmid on a trip via Highway 20 to Dalat on December 21-24, 1953, with F.A. McClure (Schmid 1953). According to this report, the populations of large spiny bamboos growing in large clumps to 25 ft in height, or forming indeterminate thickets of relatively low height, occur at elevations of 150-300 ft on old alluvial soils, sandy at the surface and sandy-argillaceous below. Such bamboos (Tre gai in Vietnamese) are quite variable in accordance with ecological conditions, but there are two main types recognized by Rollet as follows: (1) Bambusa sp., with low stature, bushy in indeterminate clumps such as found around the Forestry Station at Trang-Bom; and (2) Bambusa Blumeana on relatively rich soils in the

^aProbably Oxytenanthera sp., according to Ho (personal communication 1973).

forest borders, forming large clumps, well-delineated, with stems to 75 ft tall.

On soils derived from schists or granites, primarily on slopes between 450-2800 ft and especially between 2100-2400 ft, Lingnania sp. was found. Species of Oxytenanthera (O. dinhensis, the most common, and O. densa) were noted in areas where Montagnards practiced slash-and-burn agriculture. Other genera and species of bamboos were found by the authors on this brief trip, but, with the exception of the climbing bamboo (Dinochloa aurinuda [sic!] = orenuda) at elevations around 4500 ft, none appear to be common in the primary or secondary Closed forest ecosystem.

On the other hand, Ho (personal communication 1972) recognized two ecological types of common bamboos from the An-Loc-Tay-Ninh region, as follows: (1) Bambusa arundinacea (Tre gai in Vietnamese), a large, spiny species usually found on slopes 300-600 ft or more away from streams, but at An-Loc apparently far from water courses, very possibly due to hydromorphic soils inundated during the rainy season; and (2) Oxytenanthera, species of which occupy dry soils. Oxytenanthera albociliata was in flower at An-Loc, but other unknown species were the more common in colonization of defoliated, burned forests and abandoned ray.

Ho (personal communication 1972) also notes that he has observed Oxytenanthera densa flowering several times over a period of year at Deo-chuoi in the Col-de-Bao-Loc. He has given further notes on distribution of bamboos in SVN in the recently published second volume of his flora of the country (Ho 1972).

Finally, it is appropriate to emphasize that bamboos are rather

difficult plants to determine to species. In SVN it is obvious from the writings of Vietnamese and French botanists of the past 20 years that much work remains to be done before a complete and authoritative account of the species of bamboos can be published for that country.

EFFECTS OF HERBICIDES AND FIRE ON SPREAD OF BAMBOOS IN THE CLOSED FOREST AREA

Unfortunately, the impossibility of conducting any field studies due to security problems and the very limited opportunities for aerial observations preclude an accurate estimate of the forest areas in which bamboos may have become dominant after application of herbicides.

In the one area of sprayed forest visited on the ground at Cau Muoi-Mot, bamboos had apparently colonized the former Closed forest following the elimination of most of the upper story and subdominant trees through cutting and cultivation, followed by one or more herbicide applications (Agent Orange). The information mentioned elsewhere in the Committee's report^a suggests that despite a dominant role played by bamboos at this site, reestablishment of a secondary Closed forest may gradually take place on slopes; however, time did not permit a similar investigation of the cleared rolling land where it may be a different story. Finally, on this cleared rolling land (see Figure 1) there was evidence that some bamboos had been killed back to the underground rhizomes by the herbicide, but they were vigorously sending up new vegetative shoots, similar to those noted elsewhere by Ahmed (1957).

^aSee Section IV B(1), Part A of the Report on the Effects of Herbicides in South Vietnam.



FIG. 1. Bamboos occupying a formerly cleared area.

Obviously, this one very small sample is far from adequate to use as a basis for extrapolation to all secondary Closed forests in SVN. The data do suggest that where only one or perhaps two applications of herbicides were made, there are some prospects for regrowth of a mature forest composed of many of the dominant species, despite the presence of abundant bamboos.

To such a statement should be added the proviso that fires, particularly during the dry season, could probably destroy the young saplings and thus serve to perpetuate an understory composed mainly of bamboos. Such wild fires burning unchecked in secondary forest areas of Tay-Ninh Province were observed from 2000 ft on a helicopter flight in January 1972. The fires were especially common in severely degraded forest areas, many of which appear to have supported only bamboos (or bamboos and grasses) prior to 1960. Further, Tschirley (1972) and Blackman (1972), on a combined aerial and ground reconnaissance trip to Tay-Ninh Province on March 20 and 21, 1972, observed that a large amount of burning had been done and active fires were common west and north of Tay-Ninh City, as towards Tonle-Chan.

THE REPRODUCTION OF THE BAMBOOS COMMON TO CLOSED FOREST AREAS

It has been pointed out frequently by various authors, such as Barry et al. (1960), writing about the spread of Asiatic bamboos, that their reproduction and colonization of newly available forest areas is a relatively rapid process. Bambusa arundinacea, and possibly Bambusa Blumeana, as well as species of Oxytenanthera are the principal bamboos most commonly involved in SVN in colonizing former forest lands. Attention was thus

focused upon the reproduction of these and related (unidentified) bamboos during brief study visits to several sections of the country.

Flowering of Bambusa arundinacea was observed in the vicinity of An-Loc on February 4, 1972 in an area devastated by repeated fires following logging and possibly the application of herbicides. Most flowers were fully opened with anthers just maturing. The flowering stems (culms) arose from clumps in which many but not all stems were dead, some evidently damaged by fires. No seeds or seedlings were found.

A few hundred yards away nearer the road, a species of Oxytenanthera was found in full flower. All stems were living, but the flowers were still young with no seeds yet developed. No seedlings were found below or adjacent to the clump.

Further field observations of flowering bamboos were made on January 31, 1972 at the Forest Station at Trang-Bom where Dendrocalamus flagellifer was in full flower (anthesis). Additionally, in the Col-de-Bao-Loc area, along Highway #20, a species of Oxytenanthera was collected in flower from a large population gregariously flowering, on January 29, 1972.

It had been our intention to revisit later the sites at An-Loc, the Col-de-Bao-Loc, and Trang-Bom to verify the production of seeds from the species observed in flower in January and early February 1972. However, on the next trip in July-August 1972, it was impossible to visit the An-Loc site due to active hostilities. At Trang-Bom, on August 1, 1972, an intensive search was made for seedlings and/or seeds of Dendrocalamus flagellifer, but neither could be found under or adjacent to the flowering stems. Upon revisiting the Col-de-Bao-Loc site on August 3, 1972, it was found that most of the flowering bamboos had since been cut.

in a right-of-way clearing operation. Again, an intensive search for seedlings beneath a few of the uncut flowering stems of Oxytenanthera sp. proved negative; yet Blackman and Richards had both found mature seeds on a trip to the same area which they made in March 1972 (personal communication 1972).

According to McClure (1967) "the incidence of maturation of fruits is relatively low in the majority of known bamboos." He also noted that "abundant yields occur in only a relatively few species out of the hundred that have been observed in flower." If such statements are applicable to common bamboos in SVN, then one would not expect a high frequency of seed production. Indeed, on the basis of what data we have obtained from direct field study in SVN and the published information from a lifetime of investigations of bamboos by McClure (1967), it is reasonable to conclude that the rapid colonization by bamboos of cleared forest is not usually accomplished in SVN by production of abundant seeds and seedlings. It follows that the spread of bamboos is more likely to be by vegetative means. Spread to new areas must, however, be by means of seeds, possibly carried by birds. Where clearing operations have taken place in an area supporting some bamboos, the result often is a vastly increased population of these bamboos growing from the cut-up sections of rhizomes (Nguyen-van-Phuong, Assistant Chief Forester, Trang-Bom Forestry Station, personal communication 1972). Moreover, apparently the alteration of the Closed forest, as by extensive logging operations, or killing of the upper canopy species by herbicides, will produce ecological conditions favoring the rapid regeneration of new culms of certain bamboos (Huberman 1959). When sites with an understory of

Bambusa arundinacea and species of Oxytenanthera, as described by Boulbet (1960), are converted by the Montagnards into slash-and-burn areas (ray), the bamboos will soon occupy the sites upon cessation of cropping and will persist for a long time (Rollet 1962?).

POSSIBLE ECONOMIC VALUE OF BAMBOOS COLONIZING DEFOLIATED AND/OR CLEARED-BURNED FOREST LAND

A comprehensive review of the economic uses of bamboos does not seem appropriate for this report, but possible uses that could be made of the common species involved in the colonizing of land in the primary and secondary Closed forest ecosystem in SVN are worth mentioning. Much research has been carried out in the silviculture of useful bamboos in various countries, especially in Asia (Huberman 1959). Moreover, the economic value of many of these bamboos is very significant in tropical Asia, as noted by Ahmad (1957), Ahmad (1957), F.A.O. Study (1961), McClure (1967), and McKinley (1957), among many others.

McKinley (1957) lists the main species and uses of bamboos in SVN. Included among these principal species are two or three that are significantly involved in colonizing cleared, burned or probably also heavily defoliated Closed forest areas.

1. Bambusa blumeana has wide distribution in SVN, but it is also considered by McKinley as the most useful bamboo for many purposes.
2. Bambusa arundinacea is listed by McKinley as useful for construction purposes, and as a source of edible shoots. He (personal communication 1975) regards this species, rather than B. blumeana, as the most widespread in SVN, as well as the most useful for various purposes.

Another bamboo^a from the Closed forest ecosystem, at least in its secondary aspects, which is very much used for construction of many articles, such as furniture, poles, fences, etc., is Schizostachyum Zollingeri, known as Lo-o (not S. aciculare Gamble, of McKinley 1957).

McKinley states further that the bamboos useful for paper pulp develop rather thin-walled stems, but there is no published information suggesting that such bamboos are involved with the Closed forest successional patterns following severe disturbances.

On the other hand, McKinley notes that near Tay-Ninh there has been a paper factory utilizing bamboo shoots of about six months or age for manufacturing a kind of blotting paper. Neither scientific nor common Vietnamese names were given for the bamboo thus employed. Moreover, no specific information on uses of species of Oxytenanthera were noted by McKinley. Yet these bamboos are among the important species colonizing former Closed forest lands which have been cleared or severely defoliated by herbicides.

Finally, recent studies of the properties of Thai bamboos (Satrakom et al. 1972) for pulp and paper production show that a large number of species can be utilized in making a kraft type of paper. The best species were Dendrocalamus asper Backer and Bambusa spp., including both B. arundinacea and B. Blumeana. Earlier studies by Samapuddhi (1959) were centered upon 34 different species in 10 genera in Thailand, including species of Oxytenanthera which are also common in secondary Closed forest areas of SVN. Possibly these latter bamboos may eventually be found useful in

^aSuggested by Ho (personal communication 1973).

furnishing products of economic value, but their potential appears to be less at this time than is that for certain species of Bambusa.

CONCLUSIONS

1. As a result of centuries of slash-and-burn agriculture practiced in SVN, extensive areas support pure or mixed stands of bamboos which existed prior to the application of herbicides for military purposes.

2. Evidence from published field studies of the Closed forest (Forêt dense of French foresters) in SVN indicates that several bamboos may grow as natural components of the primary forest, but they are by no means invariably present.

3. Upon clear-cutting or extensive logging, the forest canopy is opened so that altered ecological conditions favor an increase in the population of the subdominant bamboos. Such an increase by vegetative means can be relatively rapid. Spread of such bamboos from seed appears to be rather infrequent in SVN.

4. Information derived by us from severely limited field and aerial reconnaissance of the former Closed forest region in War Zones C and D north of Saigon suggests that where defoliation has led to death of the forest dominants and subdominants with suppression of their reproduction, bamboos, if present in the area, will tend to increase with establishment of pure stands that may persist for many years. Recurrent seasonal fires tend to prevent regrowth of young plants of the original forest dominants.

RECOMMENDATIONS

1. It is recommended that an evaluation be made of the potential economic uses of the species of bamboos that have occupied former Closed forest lands as a consequence of the application of herbicides, the ravages of clear-cutting, slash-and-burn agriculture, and/or controlled fires. Possible uses to be explored include many types of construction, furniture manufacture, and pulp for making several kinds of paper products.
2. Appropriate silvicultural practices could be developed to utilize stands of the more useful bamboos where the economic potential is high.

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